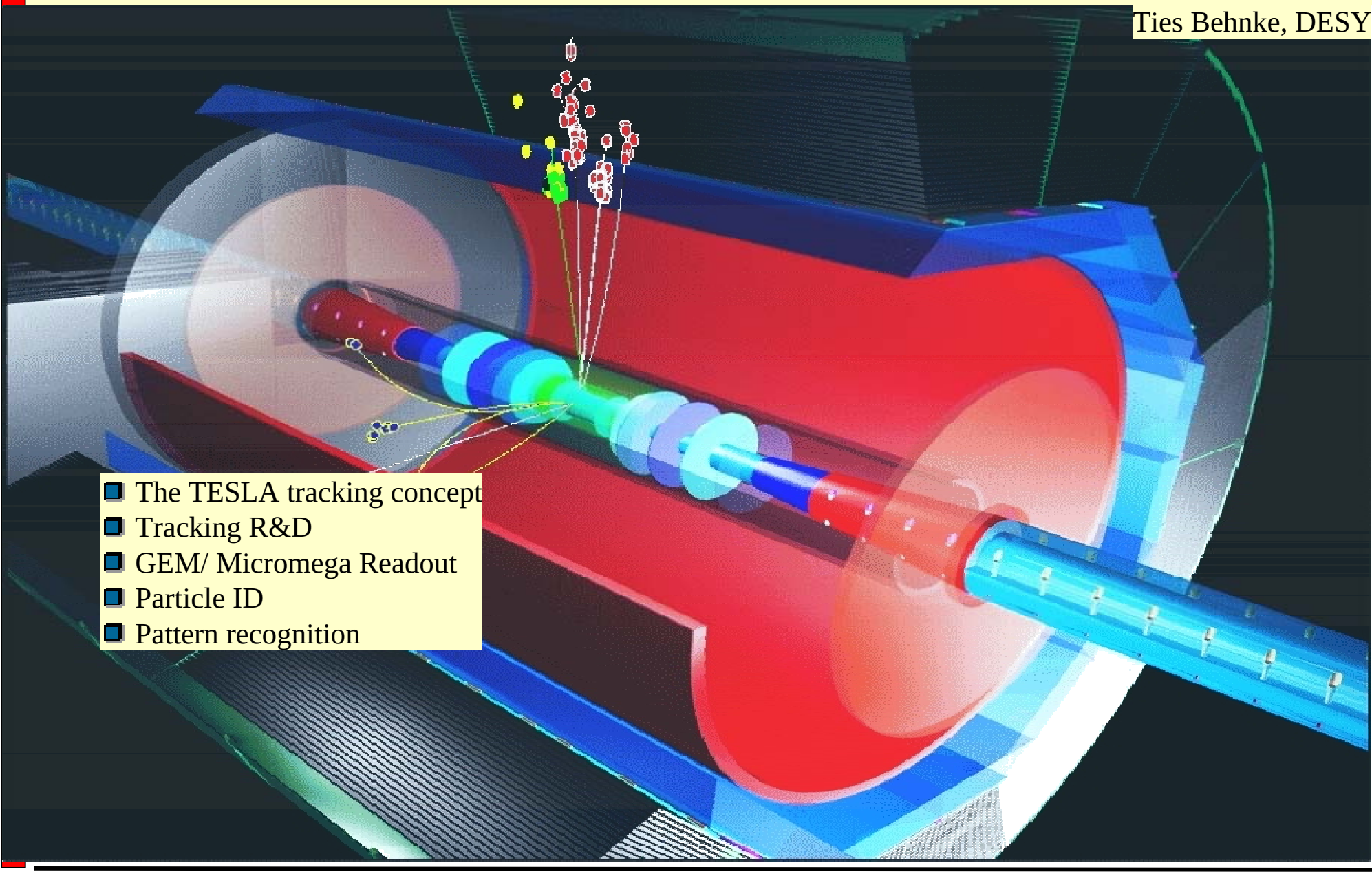
Status of the European Tracking Effort

Ties Behnke, DESY



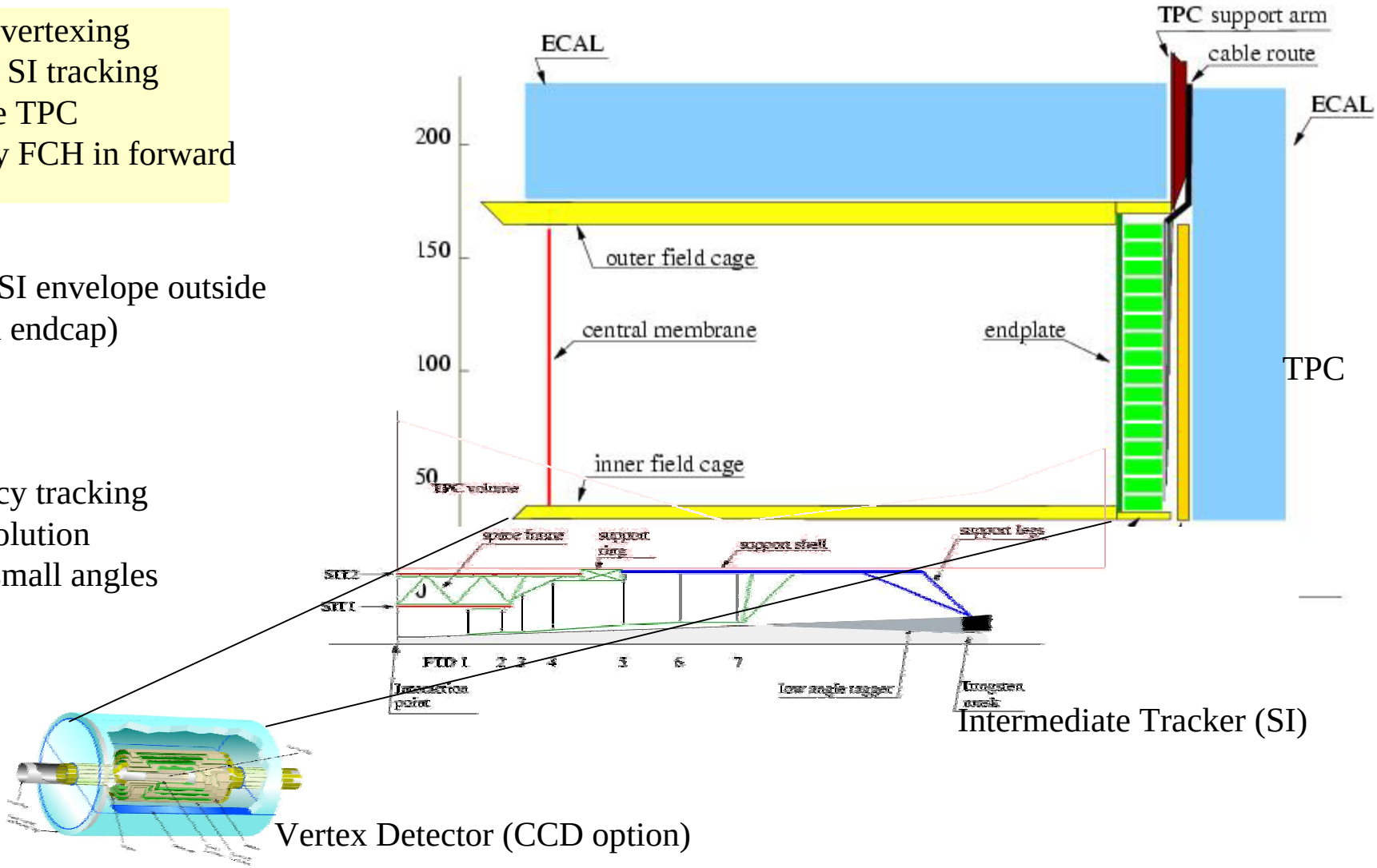
- The TESLA tracking concept
- Tracking R&D
- GEM/ Micromega Readout
- Particle ID
- Pattern recognition

The TESLA tracking concept

- high quality vertexing
- intermediate SI tracking
- large volume TPC
- backed up by FCH in forward direction

New: option of SI envelope outside TPC (barrel and endcap)

Goal:
high efficiency tracking
excellent resolution
coverage to small angles



The TPC R&D group

Detector R&D for a future linear electron positron collider:

- call for proposals by DESY, review by the DESY PRC (Physics Research Committee)
- work is not necessarily connected to TESLA, but general to LC R&D

www.desy.de/prc

DESY-PRC R&D 01/03
October 4, 2001

October 2001: proposal to the PRC by the "TPC group":

- members from
  - Canada
  - France
  - Germany
  - Netherlands
  - Poland
  - Russia
  - USA

LC TPC R&D

A Proposal to the DESY PRC

The LC TPC group

Aachen, LBNL, Carleton/Montreal, DESY/Hamburg, Karlsruhe, Kraków, MIT, MPI-Munich, NIKHEF, Novosibirsk, Orsay/Saclay, Rostock

Abstract

A Time Projection Chamber is foreseen as central tracker for a detector at the linear collider TESLA, and is being studied also for other proposals of linear electron-positron colliders. The LC TPC has to face significantly more complicated topologies and higher backgrounds than at previous e^+e^- machines, which puts stringent requirements on the overall system design. In the present document the design issues and R&D plans are presented for developing such a high-performance TPC. Particular emphasis is put on the R&D for a new type of gas-amplification system, based on micro-pattern gas chambers.

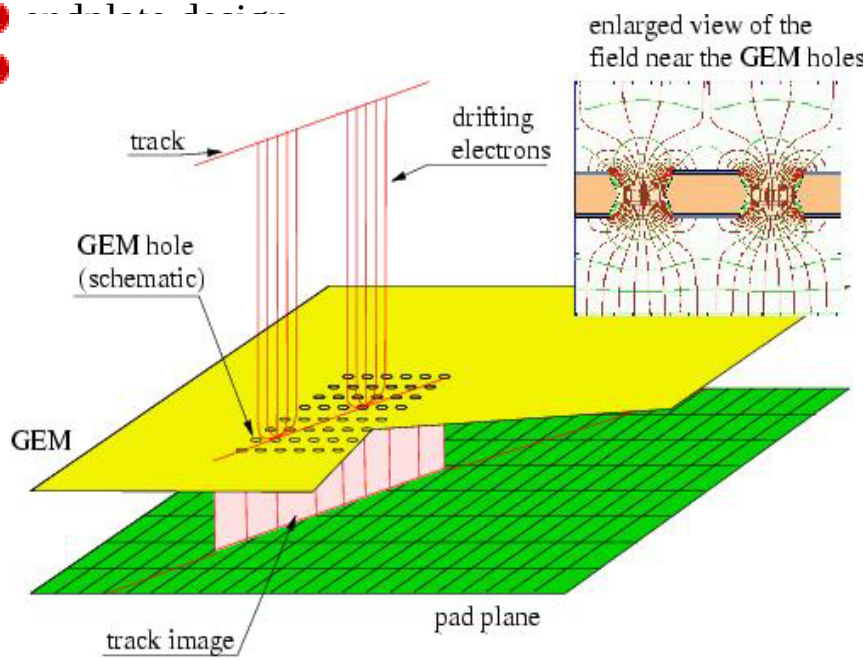
Goals:

- Develop a concept for a LC TPC
- Develop novel readout concepts (GEM's, micromegas)
- prototyping

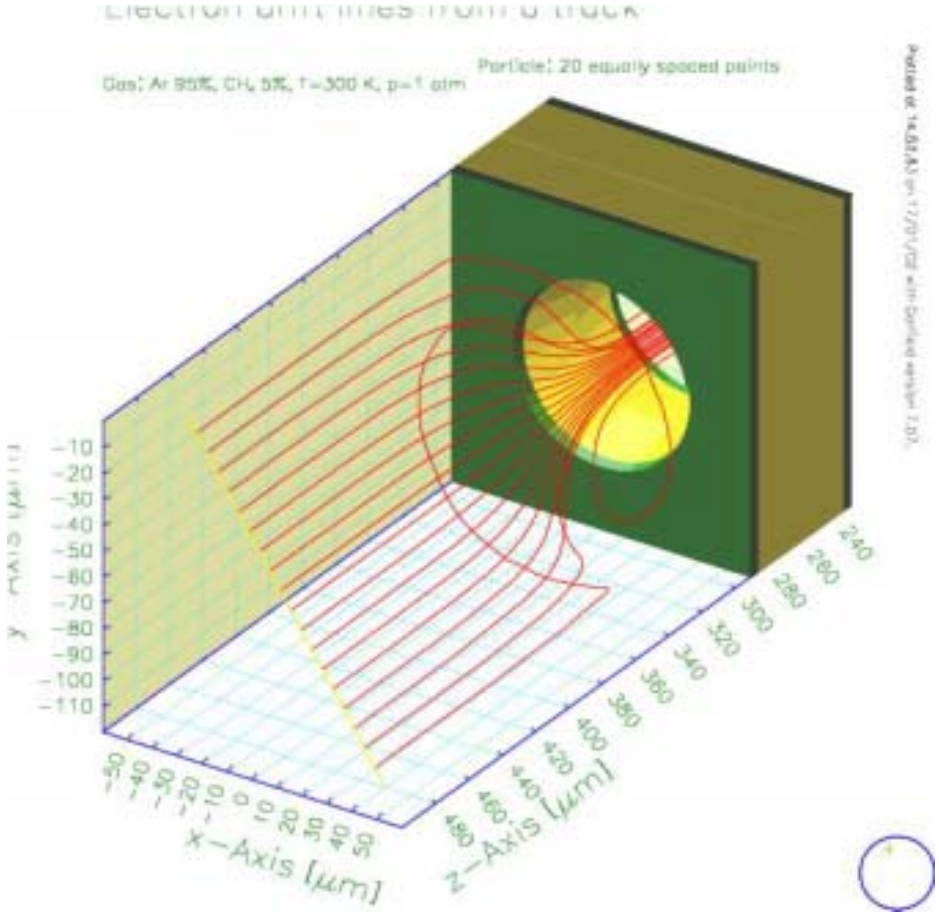
A TPC with GEM Readout

Areas of investigation:

- type of amplification system (GEM, ...)
- details of amplification system
- behaviour in magnetic fields
- resolution studies
- pad geometries
- readout electronics
- signal processing
- fieldcage design
- endplate design
-



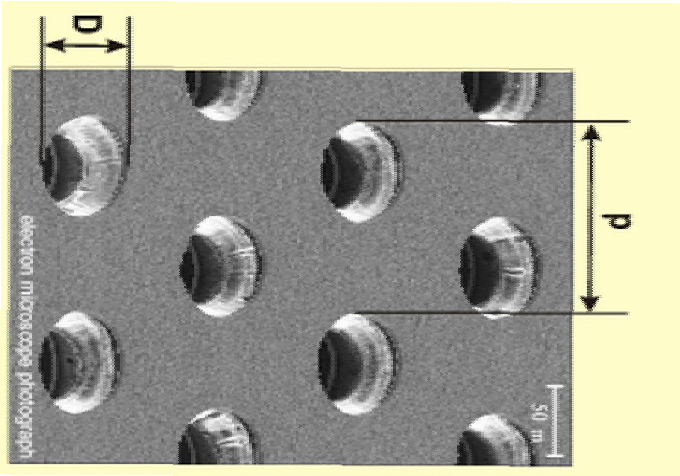
Finite Element model of a GEM cell:
solve the electric field in and around the GEM



Simulation: Aachen group

The GEM readout

GEM: Gas Electron Multiplier



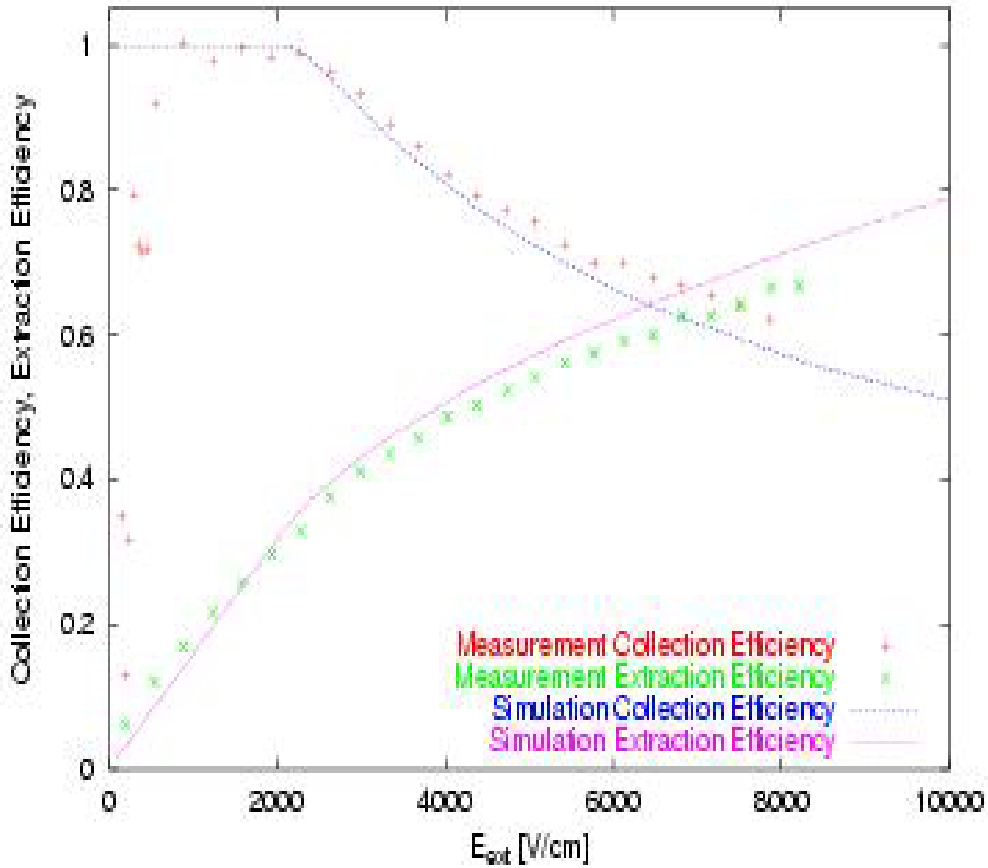
PRO:

- robust
- easy
- thin
- good transparency / ion feedback suppression

CONTRA

- some reliability problems
- small gain
- large insulator areas exposed
- not too much experience

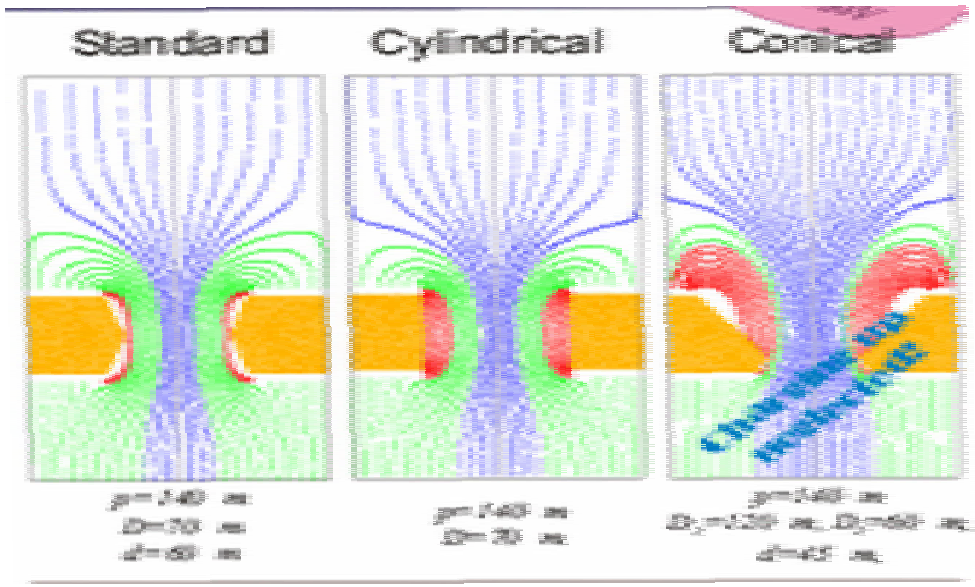
measured and calculated transmission/ collection efficiency:



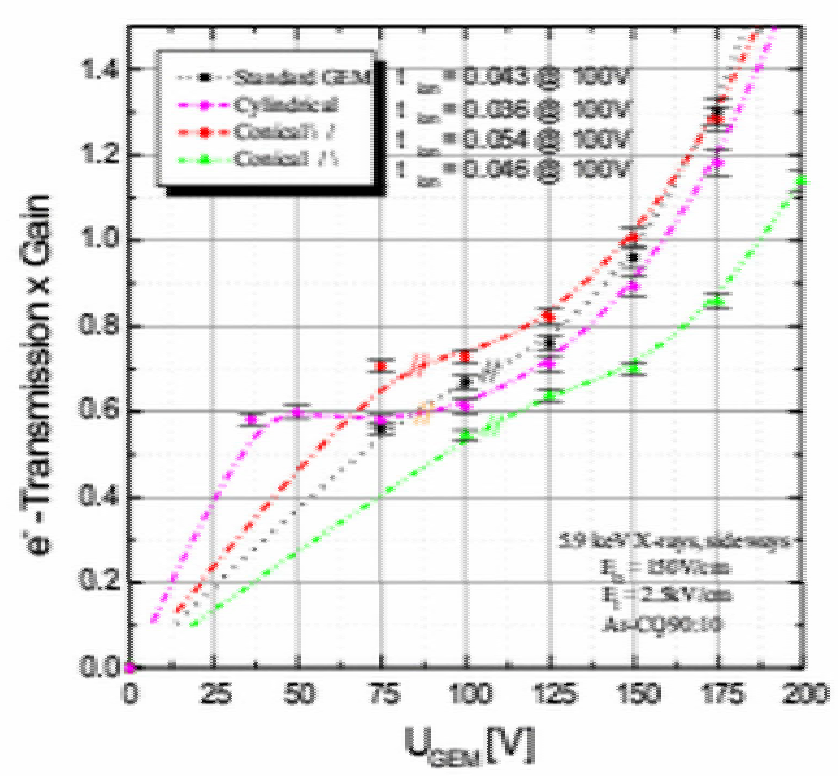
Using basically simple models, a decent understanding of the charge transport behaviour in a GEM can be obtained.

GEM developments

- Study different GEM foils (different geometries, different suppliers, ...)



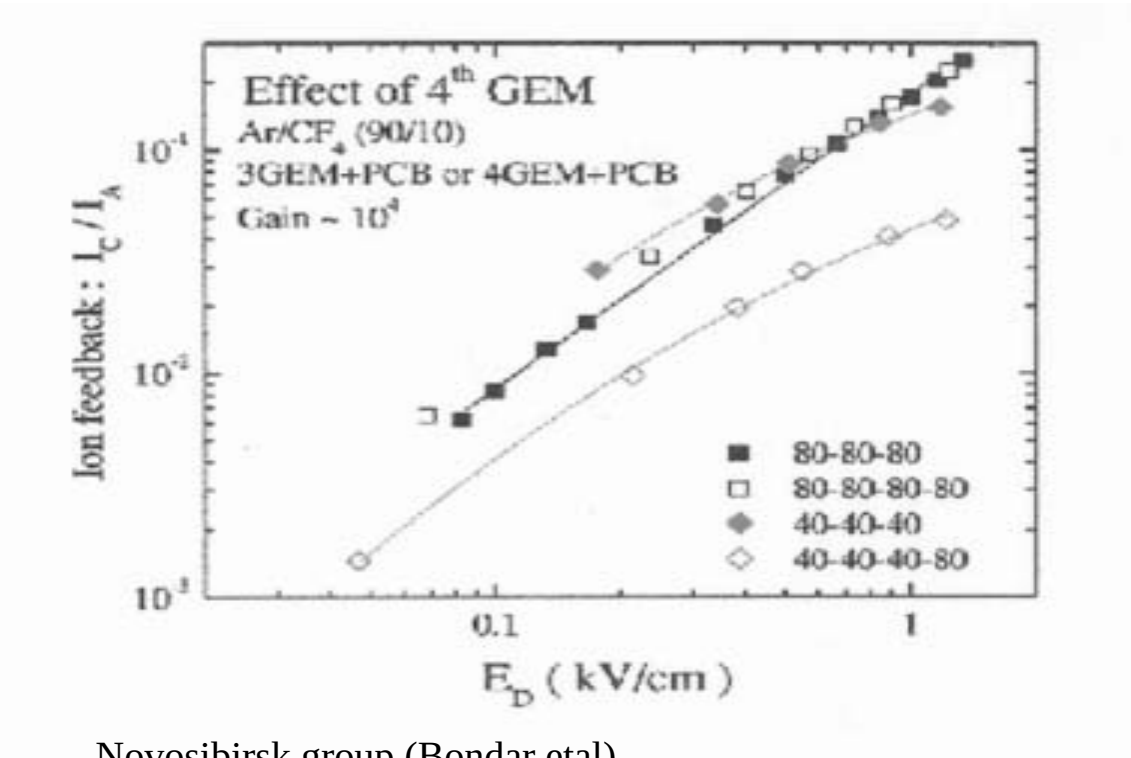
CERN/ Karlsruhe: S. Kappler



The "standard" CERN GEM (black line) is not so bad..

Ion Feedback

- A number of groups measure the ion feedback for different GEM configurations
- detailed comparisons of methods and results need to be done, but
  - essentially compatible results
  - full scan of parameter space still missing



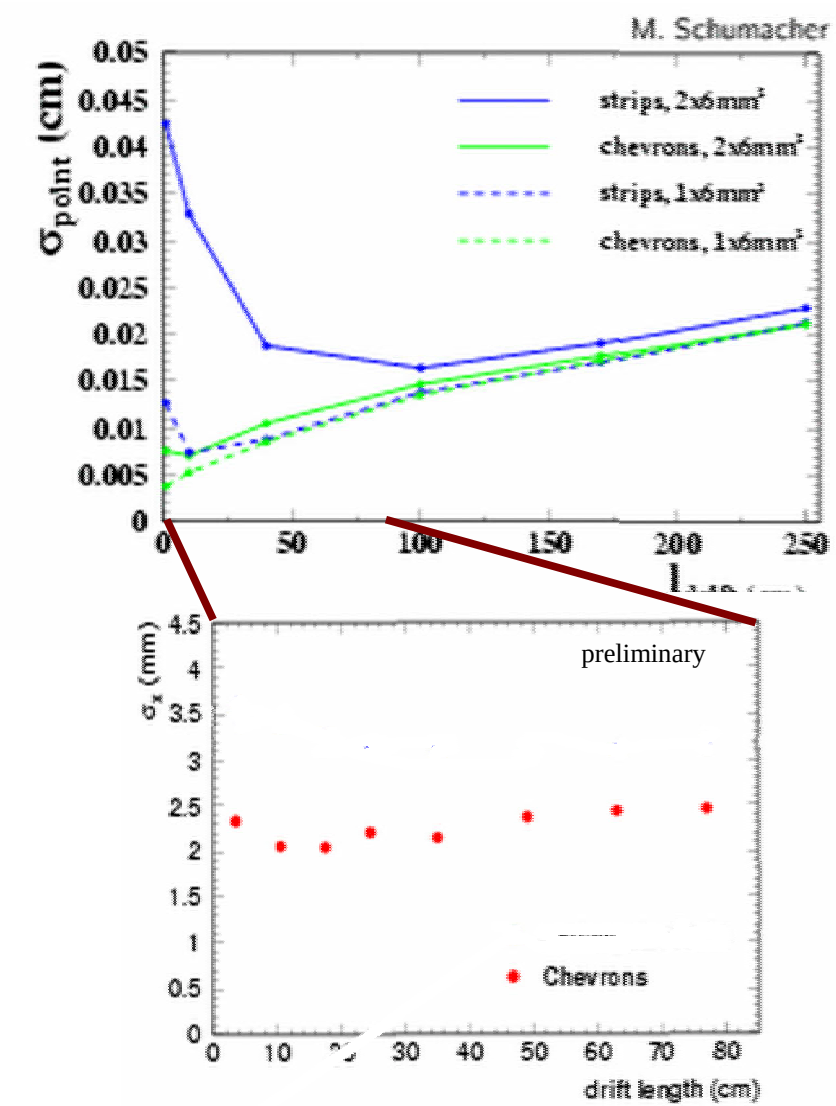
Novosibirsk group (Bondar etal)

- Ion feedback can be controlled to order(1%)
- Is this good enough? Can this be improved further?

- studies at Aachen, CERN, DESY, Karlsruhe, Novosibirsk

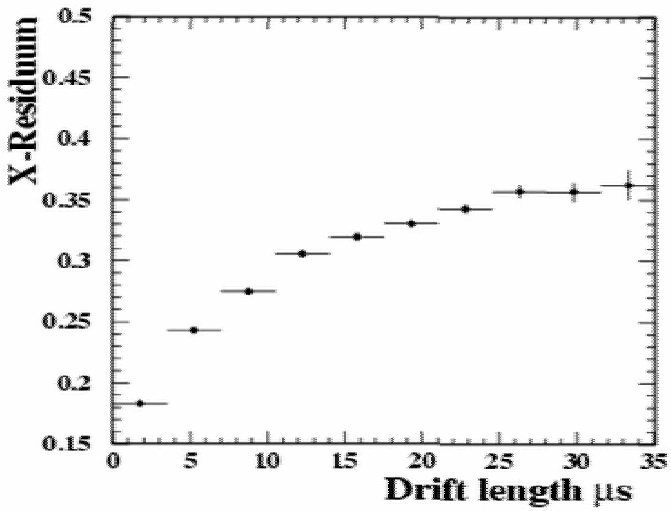
"Spreading the Charge"

"Chevron" pads: first experimental results

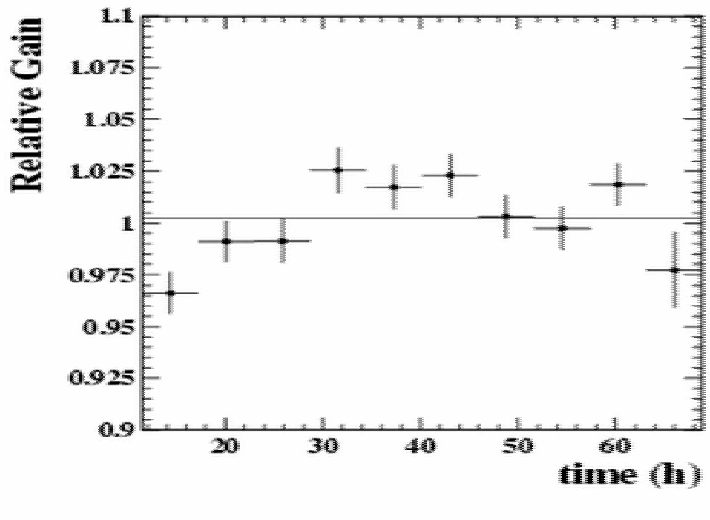


(DESY Hamburg)

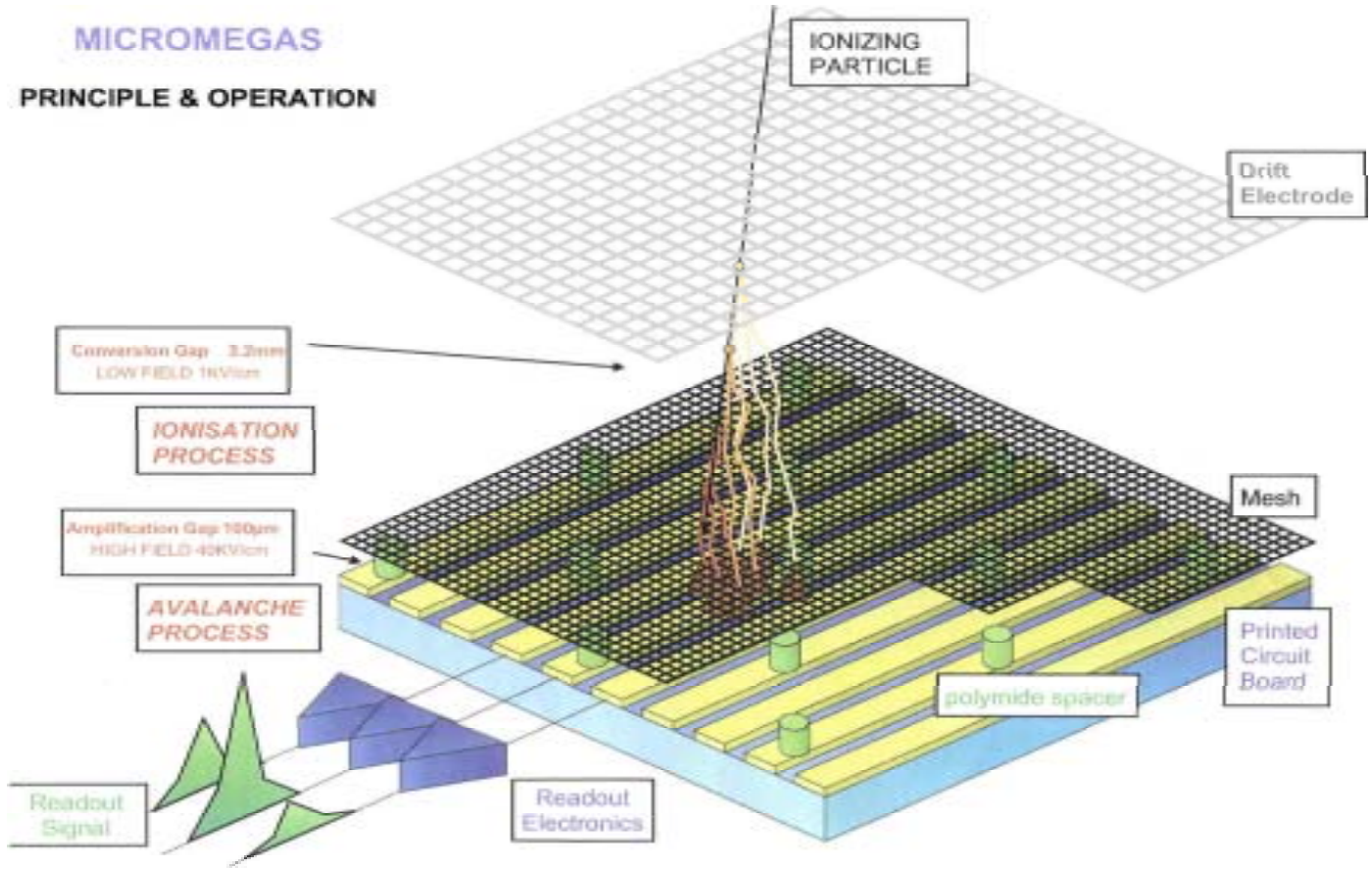
Spatial resolution



Gain vs time



The MICROMEGAS

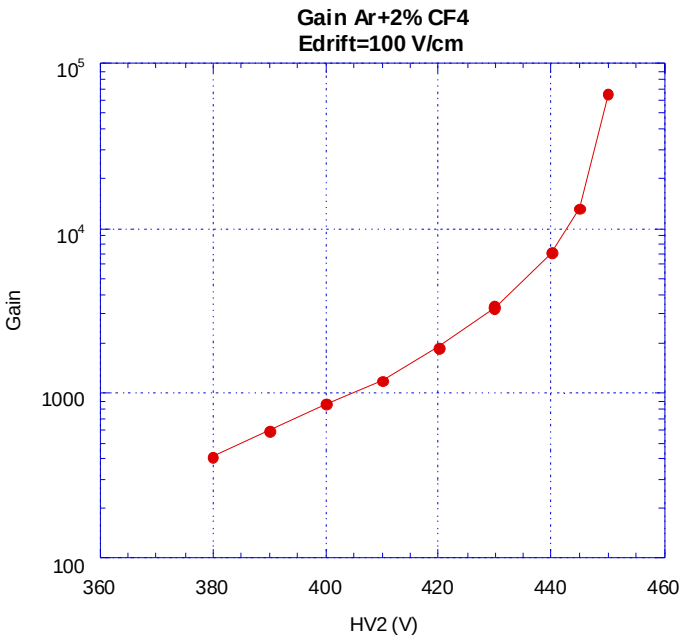


- MICROMEGAS development mostly at Orsay/ Saclay plus Berkeley
- Attractive alternative to GEM's, though less well tested.

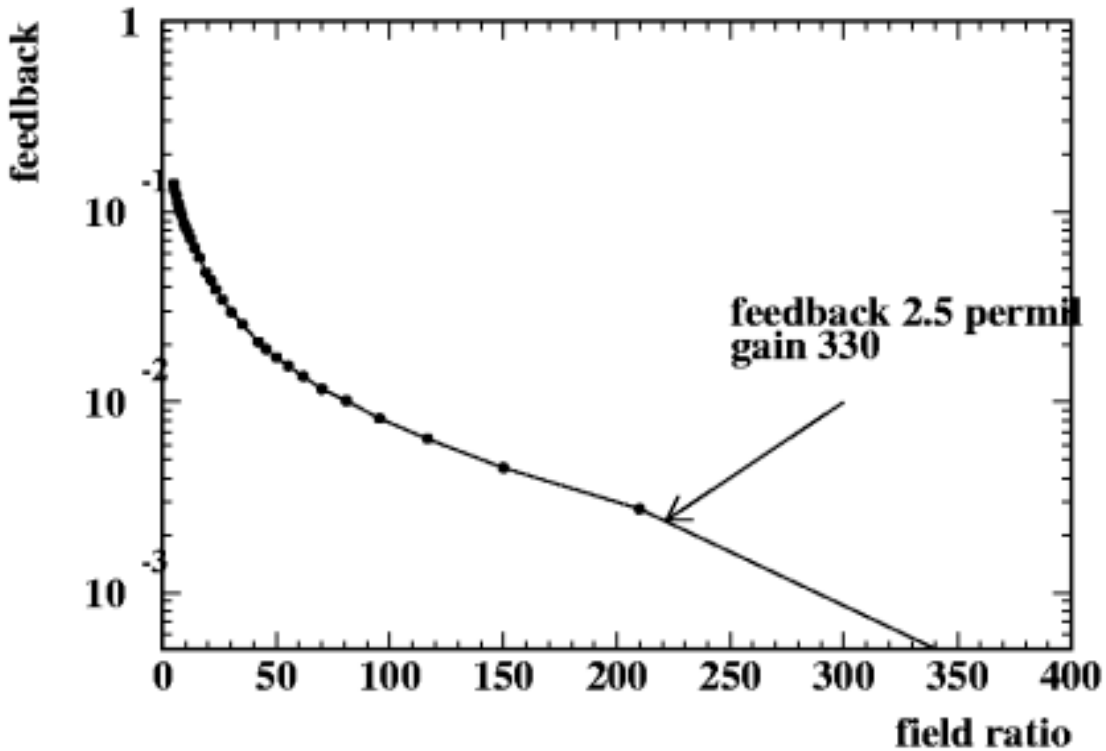
MICROMEGAS

Operation:

- gains up to 10^4
- stable operation



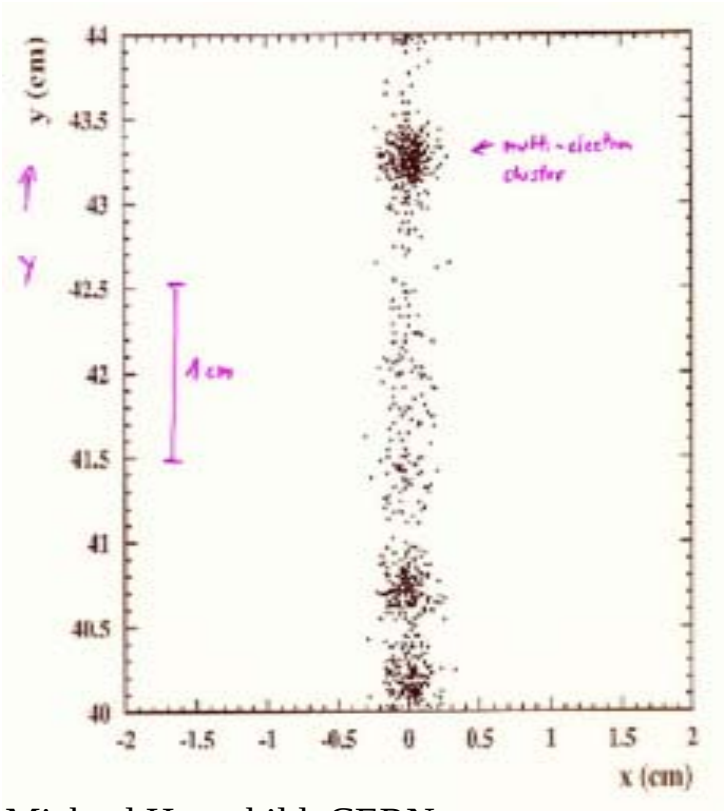
Ion feedback suppression: somewhat better than for GEM's



(for 150 V/cm drift: 33000 V/cm amplification)

dE/dx in TPC by cluster counting?

- can one measure dE/dx without actually measuring the charge: count clusters
- potential advantages:
  - no sensitivity to local inhomogeneities of the amplification system
  - potential for much simpler readout system

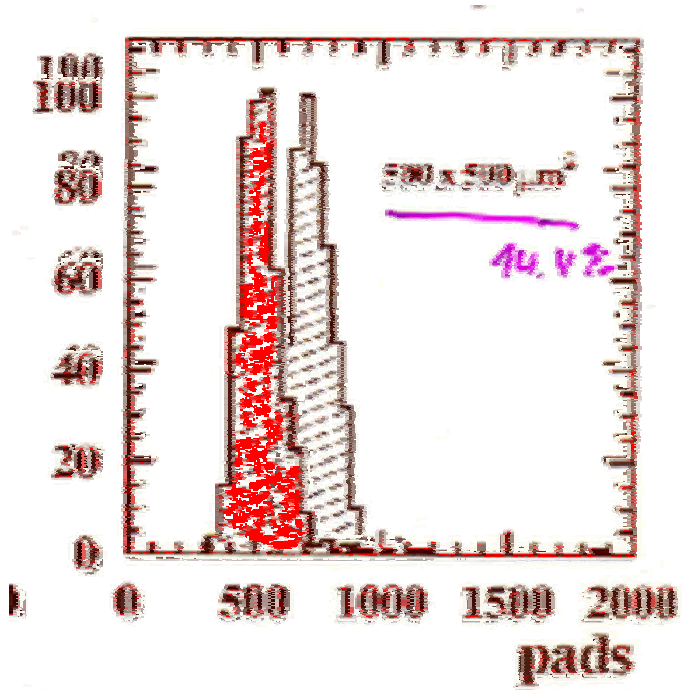


Michael Hauschild, CERN

problems: need to resolve and recognise individual clusters:
- excellent granularity
- excellent timing resolution

simulated separation between MIP and Plateau electron:

as good as "normal"

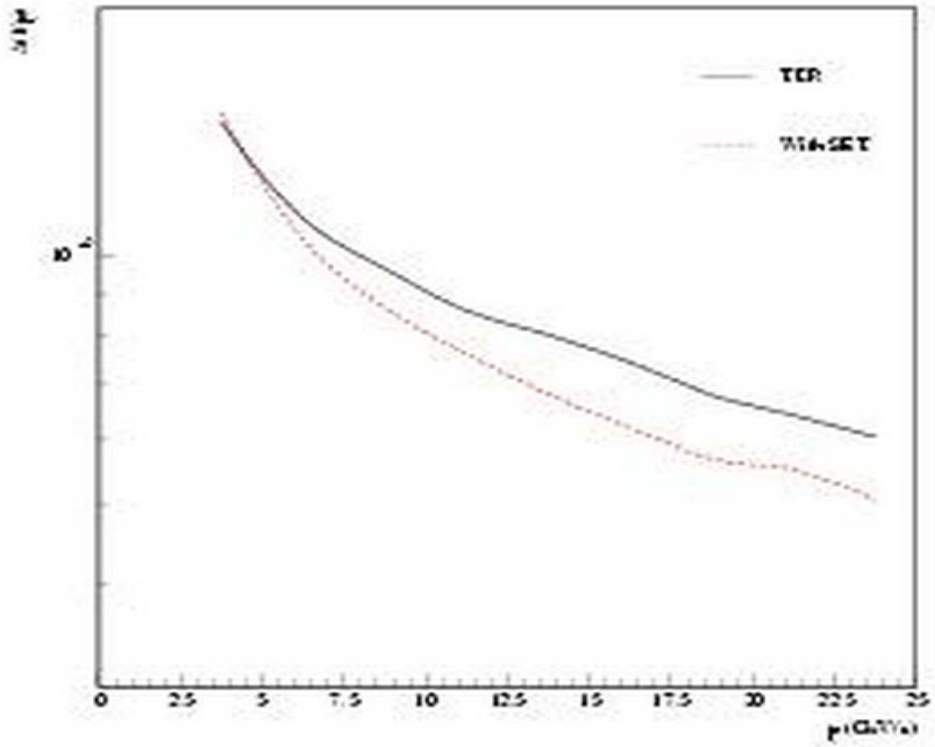


Looks interesting, needs further study

The Tracking Detector Concept: SET

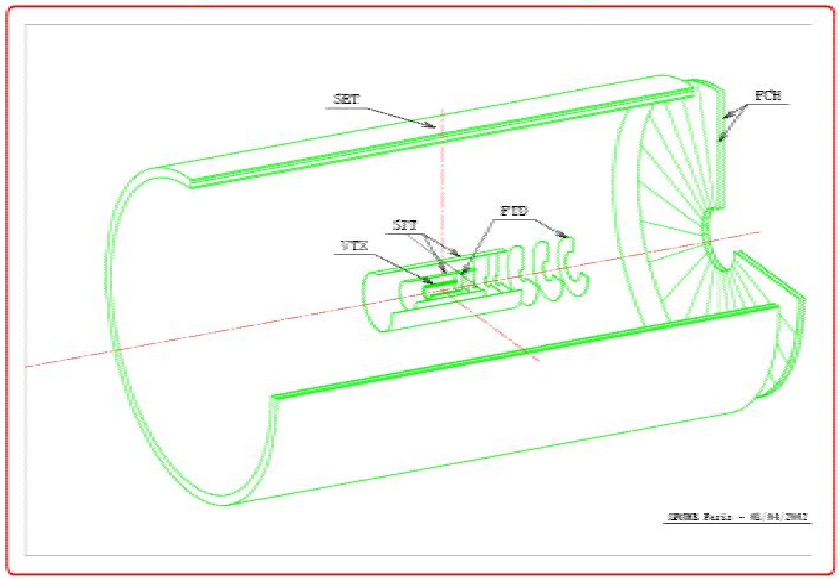
Introduce an additional SI detector just outside the TPC: SET

- improve momentum resolution
- improve extrapolation into calo
- provide precise reference point for TPC calibration



Simulation: 10-20% improved mom res

A 3D-VIEW OF THE Si ENVELOPE for the TPC
{ VTX + SIT + SET + FTD + FCH }



ASN, LPNHE-Paris 6, ECFA-DESY St Malo, 13/4/2002

SET Status

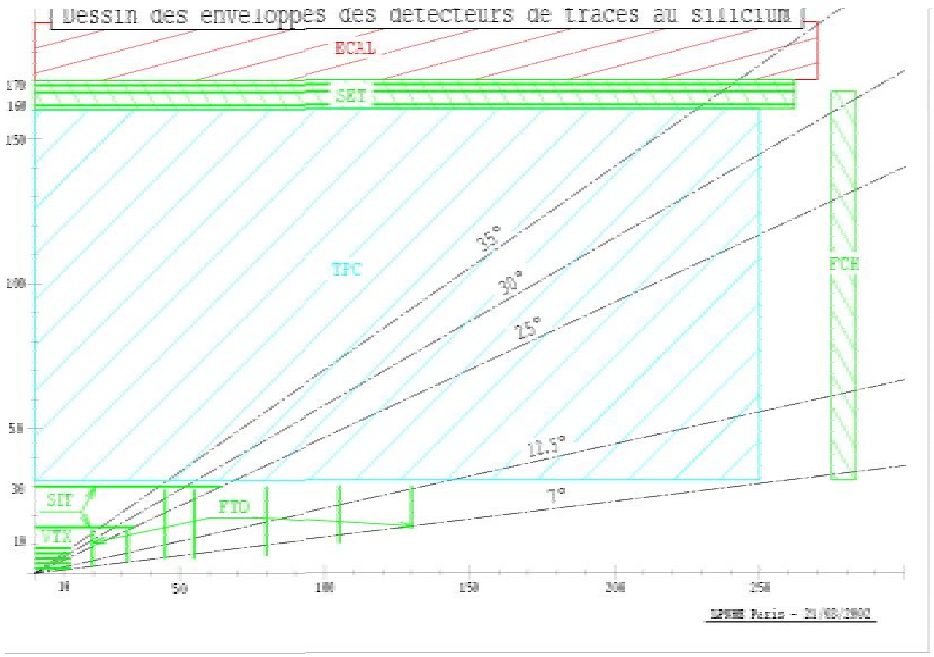
A. Savoy Navarro

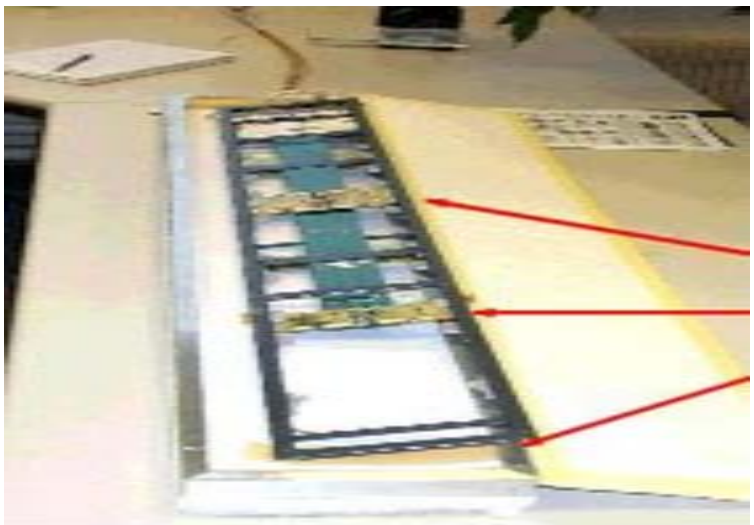
studies of the detector and its realisation have started

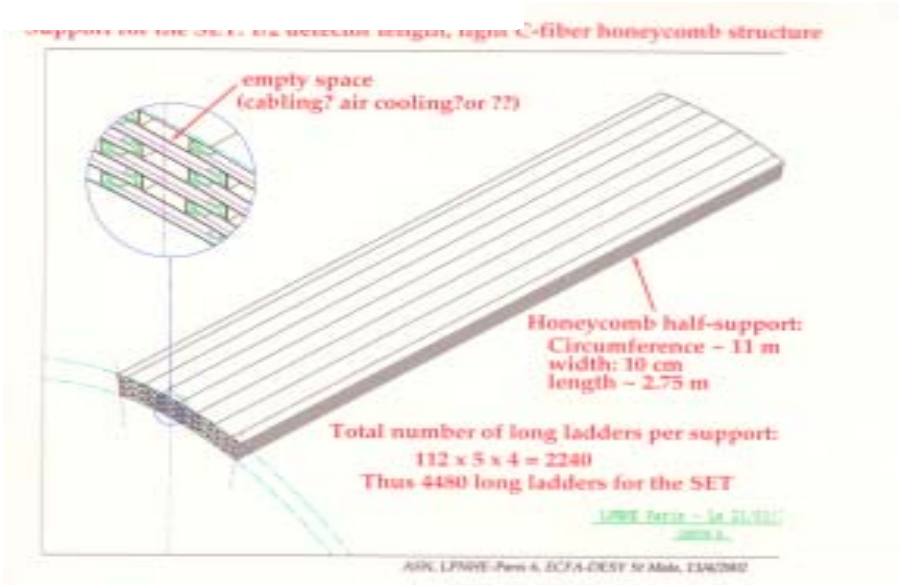
a rather detailed technical design of

- mechanics
- readout electronics
- simulation

has started in Paris





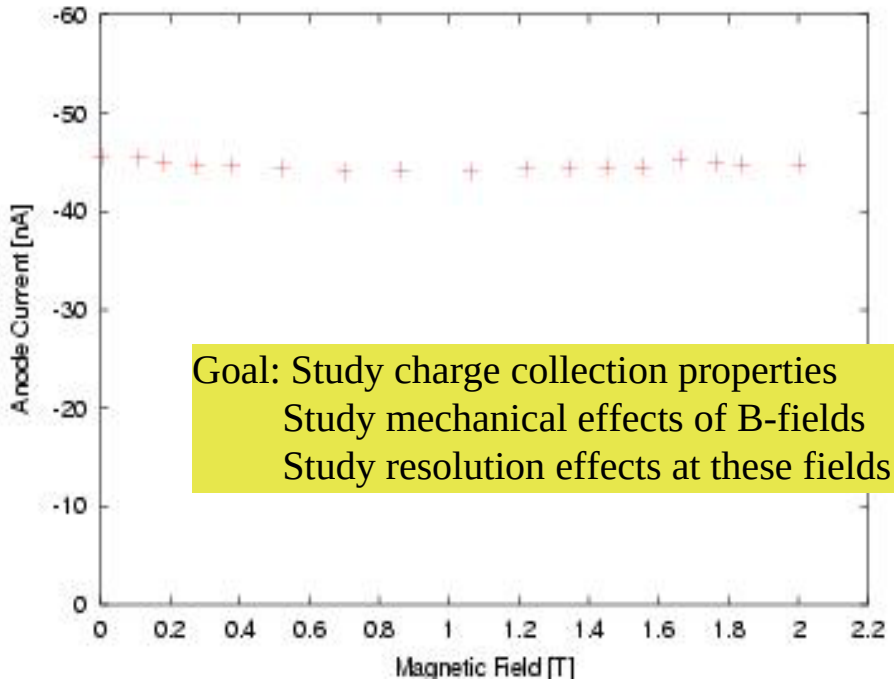


High magnetic fields

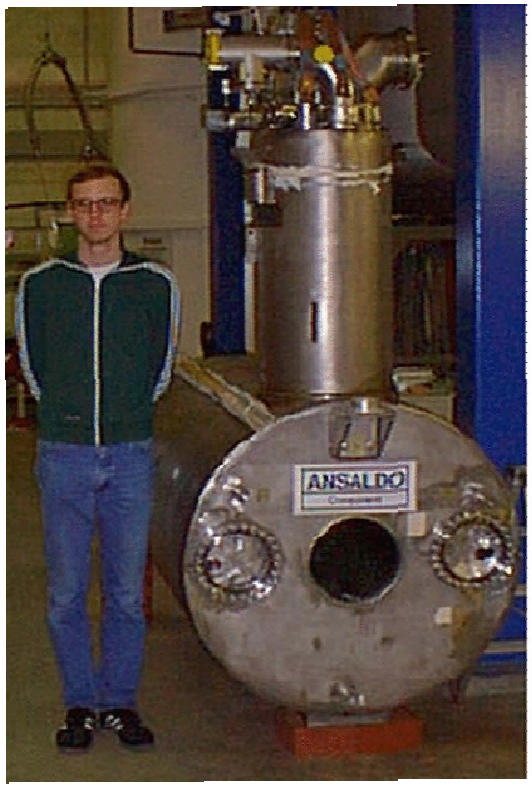
- How do MPGD work in a strong magnetic field? (TESLA=4T!)

- Saclay: 2T superconducting solenoid (ca 40cm bore)
- DESY: 4 (5) T superconducting solenoid (28 cm bore)
- "small" magnets available elsewhere

Aachen: first results on gain vs B-field:



Goal: Study charge collection properties
Study mechanical effects of B-fields
Study resolution effects at these fields

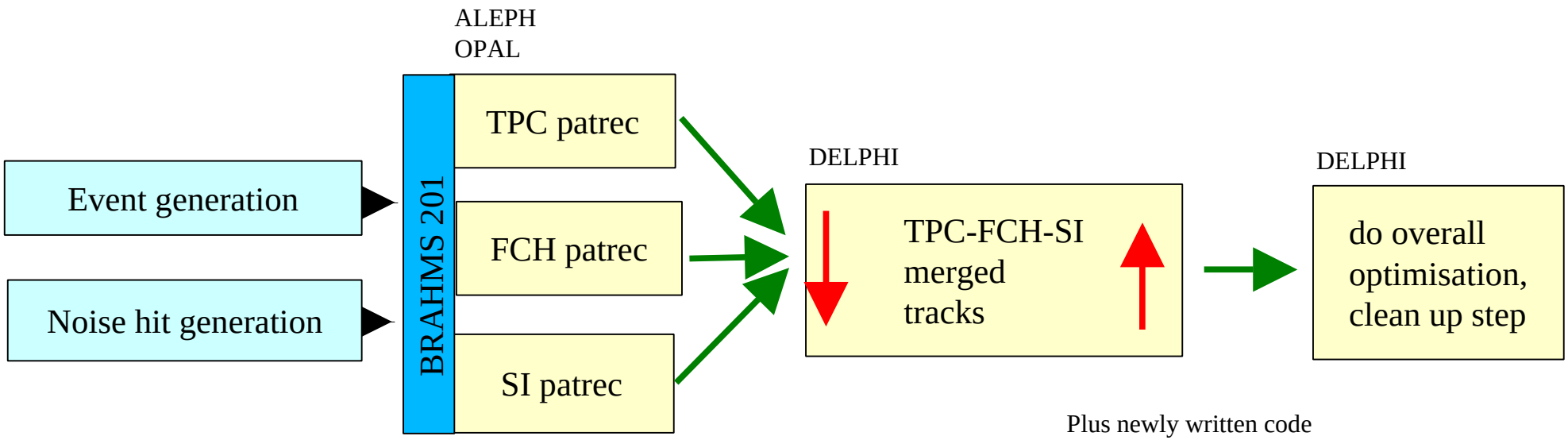


5T magnet at DESY (with grad student)

5T 27cm bore magnet test facility available at DESY from fall 2002 on; other groups are welcome to use this magnet as well!

Pattern Recognition

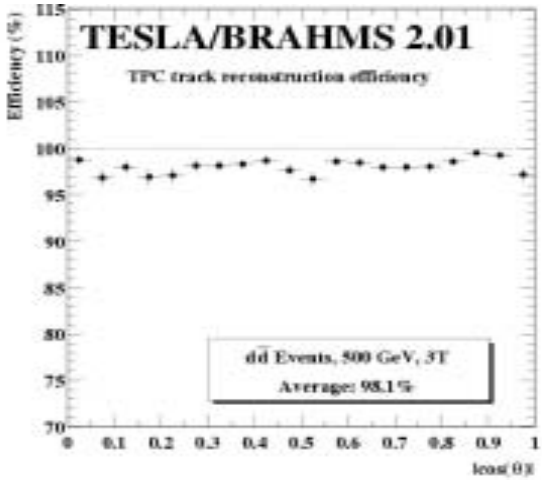
- Intense simulation effort within the ECFA DESY study:
  - Based on standard technology: GEANT3, Fortran, etc.
  - Complete simulation framework BRAHMS has been developed
    - Full simulation
    - Pattern recognition for central detector
  - Event visulation tool based on open GL
  - Reuse as much as possible existing software tools (LEP/ SLD/ ...)



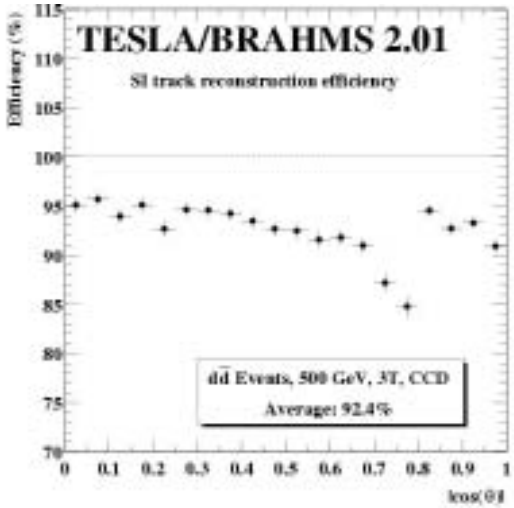
Pattern Recognition

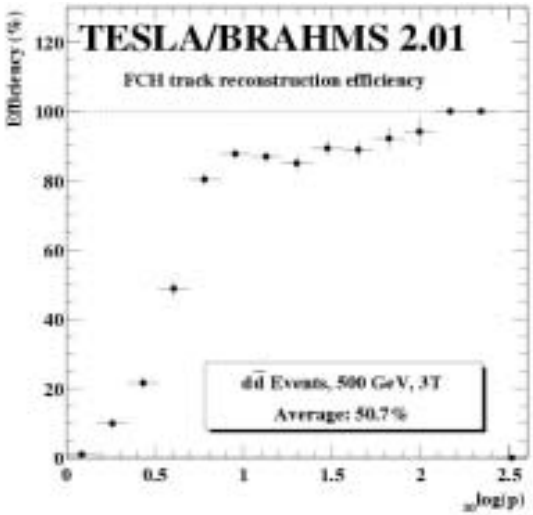
Pattern recognition efficiencies in BRAHMS

TPC alone



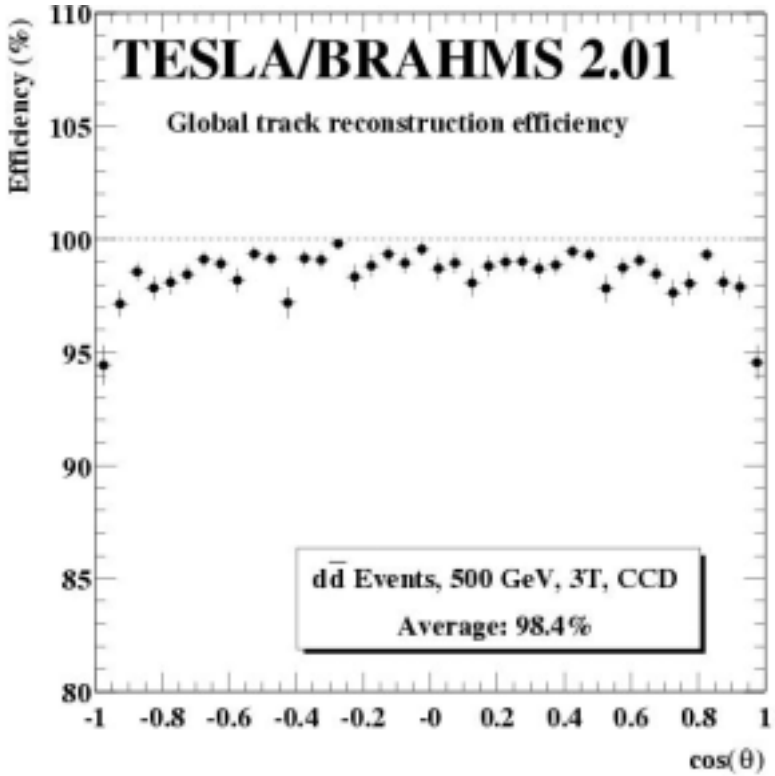
SI CCD alone





FCH alone

combined all detectors (except SET)



All plots are including background (realistic background rate)

Summary

The concept of the tracking system for a detector at TESLA is maturing.

Further refinements are under intense discussions (SET)

Hardware R&D is starting in general on a LC tracker (not just for TESLA)

Tracking software is performing well

- works in old FORTRAN based environemnt
- robust, stable in the presence of backgrounds
- speedup is needed

DESY-PRC R&D 01/03
October 4, 2001

LC TPC R&D

A Proposal to the DESY PRC

The LC TPC group

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